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Federal Communications Commission
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December 16, 1996

[redacted]

Honorable Reed E. Hundt
Chairman
Federal Communications Commission
Washington, D.C. 20554

Re: ET Docket No. 95-183 and RM-8553
RM-8811
~~ET Docket~~ No. 94-124 and RM-8308

Dear Chairman Hundt:

I am writing on behalf of WinStar Communications, Inc., in connection with the Commission's on-going rulemaking concerning, among other things, the possibility of sharing between terrestrial fixed services ("FS") and fixed satellite services ("FSS") in the 37-40 GHz band. As detailed below, WinStar believes that sharing is unworkable between the two services, especially in the 38.6-40.0 GHz portion of the band.

Although much of the 37-40 GHz band is currently without service rules, the Commission has issued significant numbers of licenses for terrestrial services in the 38.6-40.0 GHz band. As noted in Appendix E, WinStar holds licenses in that band for forty-one of the largest fifty markets in the United States. In addition to providing nationwide service as a carrier's carrier and competitive access services in twenty-seven states, WinStar will, over the next three years, roll out its competitive local exchange service in all of those markets. Indeed, WinStar has already initiated commercial service as a CLEC (competitive local exchange carrier) in New York City and intends to be operating as a CLEC in at least twelve major market areas by the close of 1997.

As detailed in the attached engineering reports (Appendices A-D), WinStar believes that sharing is operationally and economically infeasible between the FS and FSS services in the 37-40 GHz band. Although Motorola Satellite Systems, Inc.'s ("Motorola") sharing proposal assumes the contrary,

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many of its fundamental assumptions are flawed in that they are based on propagation information valid only for services below 12 GHz. Co-frequency sharing between the FS and FSS services is also unworkable because of the minimum separation distances required between the two services, normally in the tens of kilometers. Additionally, Motorola's proposed sharing criteria would hamper significantly the future development and operation of FS services in the 37-40 GHz band. Consequently, WinStar believes that band segmentation would be a more effective method of spectrum utilization. WinStar notes that band segmentation was ultimately necessary to resolve similar issues in the 28 GHz proceeding. WinStar's proposed band plan for the United States is attached as Appendix F.

Thank you for considering this matter.

Sincerely,

Phil Verveer

Philip L. Verveer

cc: Commissioner Susan Ness
Commissioner Rachelle Chong
Commissioner James Quello
Blair Levin
Jackie Chorney
Julius Genachowski
Michele Farquhar
Donald Gips
Ruth Milkman
John Stern
Karl Kensinger
Joe Heaps
Damon Ladson
Steve Sharkey
Rosalind Allen
D'wana Speight
David Horowitz
Robert James
Susan E. Magnotti
Michael Marcus

INDEX TO APPENDICES

APPENDIX A:

Document Title: ***Factors Preventing the Application of Automatic Transmit Power Control and e.i.r.p. Density Limits to Facilitate FS/FSS Sharing in Frequency Bands Above 30 GHz***

Document: ***Ad Hoc MW/DG-***

Authors: ***G. Ax***
W. Roehr
J. Dicks
W. Sonnenfeldt

Date: ***December 10, 1996***

This document describes the constraints that would be imposed on FS users by Automatic Transmit Power Control and the e.i.r.p. density limits. It demonstrates that certain of Motorola's fundamental assumptions are flawed as they are based on propagation information valid only for services below 12 GHz. In addition, Motorola has not taken into account the fact that FS operators have extensive plans to utilize high capacity spectrally efficient advanced modulation equipment that cannot function effectively with the e.i.r.p. density limitation. The conclusion reached is that the proposed sharing method is not acceptable to FS users as it imposes severe constraints on both present operating systems and future growth opportunities. The most effective method of sharing the band continues to be some degree of band segmentation.

APPENDIX B: *Document Title:* ***Analysis of the Potential for Harmful Interference Between the Fixed Service and the Fixed Satellite Service in Frequency Bands Above 30 GHz***

Document: ***USWP 4-9S/23***

Authors: ***Walter H. Sonnenfeldt***
Ross R. Sorci
Jack Dicks

Date: ***December 10, 1996***

Using characteristics of typical FS equipment in use today, as well as some now under development, the interference between the FS networks and Motorola's proposed M-Star Non-GSO satellite network has been evaluated. This document shows that the minimum required separation distance between stations of the FS and FSS services is so great that it renders co-frequency operation of these two services in bands above 30 GHz operationally and economically infeasible. The extent of interference is determined based on a number of causes, e.g., main-beam to main-beam, main-beam to sidelobe and sidelobe to sidelobe. In cases where the interference exceeds the agreed criteria of -13db, a minimum required separation distance between the stations must be calculated. Depending on the specific interference condition, the separation distances range from a worst case radius of approximately 96 Km to a minimum of 570 m. Since the M-Star earth station scans a circular area of 22° above the horizon, the minimum actual separation would normally be in the tens of kilometers, depending on the actual location and pointing direction of the FS interfering stations.

APPENDIX C: *Document Title:* ***Identification of Frequency Bands Above 30 GHz for Use by the Fixed Service***

Document: ***USWP 9B/3 Rev. 1***

Authors: ***Denis Couillard***
Jimmy Hannan
Ferdo Ivanek
Joseph M. Sandri, Jr.
Walter H. Sonnenfeldt

Date: ***November 19, 1996***

This document is a proposed contribution to Section 7.5 of the CPM-97 Report addressing the WRC-97 agenda item concerning frequency bands above 30 GHz. ITU-R studies to date provide an indication that high density fixed terrestrial and satellite services with co-located or closely spaced subscribers are in principle incompatible for band sharing purposes. The conclusion reached is that in the case of the 37.5 - 40.5 GHz and 47.2 - 50.2 GHz bands, the use of band segmentation would allow each service to be deployed to its full potential in terms of subscriber density, system capacity, service quality, cost effectiveness, and spectral efficiency.

APPENDIX D: ***Document Title:*** ***Memorandum to Pantelis Michalopoulos regarding: Millimeter Wave Drafting Group -- AD Hoc MW Document 49***

Authors: ***Joseph M. Sandri***
Michael F. Finn
C. Grace Campbell

Date: ***November 13, 1996***

Appendix A - Fixed Service Point-to-Point Hubs:

This document provides a general description of WinStar plans to implement its networks to meet user requirements, and the expected manner in which long term growth will be accommodated. Information also is provided on the anticipated spectrum efficiency that will be realized.

Appendix B - Sharing Analysis Between the Fixed Service and Fixed Satellite Service in the 37 - 40.5 GHz Frequency Band:

This document presents an evaluation of the impact that Motorola's proposed M-Star satellite system, together with the sharing criteria proposed by Motorola, will have on Fixed Service users in the 37 - 40.5 GHz band. The document concludes that Motorola's proposed sharing criteria would severely restrict future FS operations and development, and that band segmentation would be a more effective method of spectrum utilization. The severe constraints that the proposed use of ATPC and the e.i.r.p. density limit of -28.4 dBW/MHz would have on FS users are discussed. The level of interference was calculated for each of the potential interference conditions, e.g., the downlink interference from M-Star satellite into the FS receivers, and the interference from the FS transmitters in the FSS earth station receivers. Some inconsistencies in the M-Star application are also identified.

APPENDIX E:	*Document Title:*	*WinStar Press Releases* *The WinStar Network -- Background*
	Dates:	*December 4, 1996* *November 13, 1996* *November 6, 1996* *October 25, 1996* *August 26, 1996* *August 22, 1996* *August 13, 1996*
APPENDIX F:	*Document Title:*	*Proposed Band Plan For* *The United States Re: 37-40 GHz*

APPENDIX A

Contribution To Ad Hoc Millimeter Wave Advisory Group
Of the WRC-97 FCC Industry Advisory Committee

Authors: G. Ax
W. Roehr
J. Dicks
W. Sonnenfeldt

Document Ad Hoc MW/DG-
10 December 1996

References: Document No. Ad Hoc MW/DG-1
Document No. Ad Hoc MW/ 40-Rev.4 (DG-3)
Document No. Ad Hoc MW/ 48 (DG-4)
Document No. Ad Hoc MW/DG-7
Document No. Ad Hoc MW/DG-8

Input to Section II C(ii)

Factors Preventing the Application of Automatic Transmit Power Control and e.i.r.p. Density Limits to Facilitate FS/FSS Sharing in Frequency Bands Above 30 GHz

1. Introduction

Documents Ad Hoc MW/DG-7 and DG-8 presented by Motorola primarily address the proposed application of Automatic Transmit Power Control (ATPC) and e.i.r.p. density limitations that hypothetically could be applied to redesign Fixed Service systems in an attempt to facilitate cofrequency sharing between Fixed Service and Fixed Satellite Service systems in bands above 30 GHz. As shown below, a requirement to redesign Fixed Service systems to incorporate e.i.r.p. density limits and ATPC would severely constrain coverage and service capabilities, is not technically practical from an equipment perspective, and would likely increase rather than decrease inter-service interference.

It must be recognized that the use of ATPC on future FS links will not change the thousands of links already deployed and providing service to end users in the range of 37-40.5 GHz in the United States and overseas. In addition, the broadband bit rates (OC-1 and higher) demanded by users, in conjunction with the 50 MHz bandwidth licensed by the FCC, require the use of relatively sensitive QAM modulation formats. These QAM formats result in comparatively high power level requirements to meet necessary performance objectives. The use of ATPC in conjunction with an e.i.r.p. density limitation will restrict these systems to unreasonable short distances that would be measured in meters rather than Kilometers.

Motorola has not addressed our concerns regarding the service and coverage aspects of deploying an unproven low - power FS type system dependent on extensive use of ATPC.

Moreover, Motorola ignores the deleterious impact that imposing power density limits and ATPC would have on plans to deploy advanced technology systems now under development and close to procurement. In addition, it appears they have relied heavily on references related to ATPC that specifically indicate that further study is required before the referenced technique can be extended above 12 GHz, such as TIA Bulletin #TSB 10-F. (See Annex 4). Finally, and of tremendous importance, Motorola has refused to address the significant impact of uncorrelated fading effects even though this major problem has been repeatedly raised.

2. Use of Automatic Transmit Power Control

Ad Hoc MW/48 identifies a number of issues that clearly demonstrate that the intensive application of ATPC in the 37 - 40.5 GHz band will not remove the difficulty of both services meeting their stated service objectives, and could worsen the results of such efforts. One major issue raised in that document that has not been addressed to date is that of non-correlated fading, and its impact on both FS and FSS operations.

2.1 System Design Issues

Motorola in its documents continues to present information relating to an unproven method of low-power operation of the Fixed Service, which requires that FS operators hold their transmitted e.i.r.p. density to extremely low levels and demands the use of an extreme level of ATPC. The deleterious impact of their proposed low e.i.r.p. density is discussed in Section 3 below.

In Ad Hoc MW/DG-7 and elsewhere, Motorola states that it has relied heavily on TIA Telecommunications Bulletin #TSB 10-F "Interference Criteria for Microwave Systems" in developing its response to Ad Hoc MW/48 . In our earlier response, we referenced this document and in particular Section 4.3 titled " Automatic Transmit Power Control in Digital Links". We believe that a careful reading of this whole section would leave the reader no other view than that the application of ATPC in the bands in question here by the FS, as proposed by Motorola, is wholly unsupported by TSB-10F since the data contained in this section applies generally to the use of ATPC below 12 GHz. In particular, Section 4.3.2 provides a good summary of the factors to be taken into account by users of the FS when using the limited range of ATPC considered as potentially achievable (i.e., 10 to 15 dB). The impact of the use of ATPC is measured and quantified both in terms of power level increase per event and on an annual basis. In concluding this section, the statement is made that *"The cumulative yearly time at maximum transmit power and the maximum transmit single power duration event time of five minutes may not be appropriate for radios operating above about 12 GHz due to the impact of rain rates and duration on interference cases. Further study in this area is needed"*.

Motorola cannot credibly conclude from this reference that the application of ATPC in the manner and for the purpose they have proposed has any technical basis in the bands above 30 GHz.

2.2 System Implementation Issues

There can be no disagreement on the fact that the FS radio transmissions in the range of 40 GHz are impacted differently by rain related factors than those transmitted below 12 GHz. In frequency bands above 10 GHz where rain attenuation is significant, the use of ATPC as proposed by Motorola to overcome the resultant signal fading can result in unintentional harmful interference to adjacent links operating in the low-power mode, due to rain scattering and sidelobe interference. For example, during heavy rain, the resultant increase in transmit power due to ATPC will result in higher levels of sidelobe interference and signal scattering by rain cells. Adjacent links which are not affected by the rain (and which are continuing to operate under the low-power condition) could receive significant interference, and considering the amount of power control necessary at 38 GHz, the interference level could be extremely detrimental to overall performance. The victim receiver no longer has a substantial margin against such interference. Annex 1 illustrates one example of rain induced interference to systems in the FS.

It should be noted that current FS systems would not be substantially impacted by FSS downlink interference except for Mainbeam coupling during a fading event. On the other hand, implementation of FS ATPC would cause FS receivers to operate in the equivalent of a faded condition at all times, rendering them susceptible to FSS downlink Mainbeam to FS Sidelobe interference during a substantial percentage of every satellite pass.

2.3 Power Control Implementation

In Ad Hoc MW/DG-8, Motorola freely quotes from the above referenced TIA Bulletin the benefits to be derived from the use of ATPC as described in the INTRODUCTION (Section 4.3.1.) to Section 4.3 on ATPC in Digital links. On the other hand, the significant constraints, system design relationships, and the fact that the technical data should not be considered representative of performance above 12 GHz, as described in detail in Section 4.3.2, are ignored. Of particular importance is the fact that this bulletin states that further study is needed for consideration of ATPC applications above 12 GHz.

In Section 3 of this document, generalized comments pertaining to how ATPC improves various factors are made, i.e.,

3.1 Link Availability will be increased with ATPC
3.2 Total Life Cycle Cost will be Reduced with ATPC, and
3.3 Coordination will be simplified by the use of ATPC

Further, in Appendix B, a design approach for implementing ATPC in FS equipment is described.

We do not concur with the conclusions reached by Motorola, nor are the conclusions in full agreement with all of the leading microwave radio equipment manufacturers. Some of the more significant reasons why the assumption outlined in Appendix B cannot be implemented, as proposed by Motorola, are as follows:

(i) Thousands of presently installed FS transmitters are not equipped with ATPC. Costly redesign and total replacement of equipment would be required - at least 33 - 50 % increase in equipment cost to achieve > 10 dB of ATPC.

(ii) Using available 15 dB of FS ATPC with -22 dBW/MHz power density yields totally unacceptable Fixed Service path lengths of only 100 meters to maintain hypothetical interference protection to FSS at > 1 km radius from earth stations.

- If desired Fixed Service path length is maintained by increasing power, 1 km "FSS secondary zone" increases out to as much as a 42.5 km radius.

(iii) Implementing ATPC requires two-way Fixed Service links - - it would preclude one-way service.

(iv) Contrary to Motorola's claim, ATPC will not make FS equipment more reliable.

- Addition of ATPC will add failure points likely to reduce not increase MTBF

- Use of PIN diodes to implement ATPC, as advocated by Motorola, also will require additional filtering, cost and complexity to avoid generating intermodulation and spurious interference.

(v) Motorola's examples of its own millimeter wave ATPC implementations to multi-million dollar installations are solid testimonial to the impracticability of applying ATPC to mass-market FS terminals as proposed.

3. Adverse Impact of E.I.R.P. Density Limitation

In Ad Hoc MW/48, we stated clearly that the requirement to meet an e.i.r.p. density limitation of -28.4 dBW/MHz would have an unacceptable impact on both present and, in particular, future system development. In its latest response, Motorola has proposed that the limit could be increased by 6.4 dB to -22 dBW/MHz.

Reviewing the examples provided by Motorola as to how the FS could operate in a low-power mode, we note that the C/N ratio remains at the 8 dB level. In addition, Motorola exclusively uses 2 foot diameter antennas even though a 1 ft diameter antenna is normally used on the shorter length links. As stated in Document USWP 9B/2 and referenced in Ad Hoc MW/48, high capacity FS systems now in development and expected to come into use in the near future employ high spectral efficiency advanced modulation techniques that will require receive C/N ratios in the region of 20 to 30 dB and higher, e.g. 256 QAM = 32dB. In order to maximize their usefulness the e.i.r.p. levels will have to reach the 40 dBW level and in the long term, the full authorized level of +55 dBW is expected to be utilized. Annex 2 and 3 attached have been extracted from this document for information purposes.

In Ad Hoc MW/48 the following examples were pointed out (using -28.4 dBw/MHz):

(i) An off-set OQPSK system results in approximately 7.5 dB margin at 1 km for many locations in the U.S. For example, in New Orleans, to meet the required availability of 99.999%, the distance would be limited to around 0.5 km.

(ii) Assuming only free space propagation losses on the FS link, insufficient signal level is received for an advanced 256-QAM system even for a path length of only 0.5 km. In fact, the margin is used up after only 0.25 km distance. A 16-QAM system only has a margin for normal operation of 0.7 dB at a path length of 1 km.

With an increase of 6.4 dB in e.i.r.p. density, the distances given above for these systems would be approximately doubled. Furthermore, besides the distance being insufficient, the performance would be dependent on as yet unproven ATPC control algorithms.

Conclusion

In reviewing all the information provided to date, it is clear that the FS cannot operate in the low-power mode with an e.i.r.p. density limitation, and still be in a position to meet its service objectives. Major problems with no ready solution raised several times by the Fixed Service parties remain unaddressed by Motorola and serve to demonstrate the unworkability of their proposals:

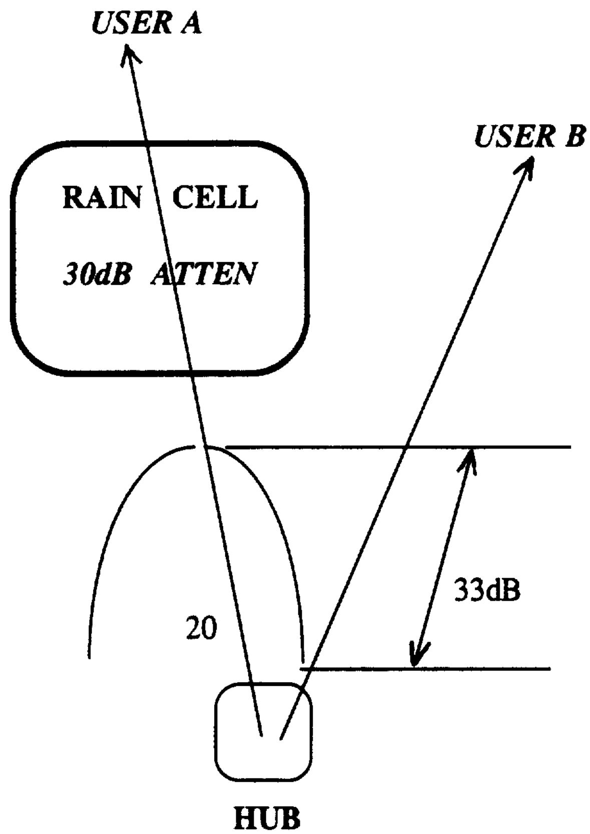
i) the overall system impact on FS system operation of uncorrelated fading,

ii) the introduction of new systems using spectrally efficient advanced modulation methods, and

iii) the ability to fully utilize the maximum e.i.r.p. power level authorized.

The only viable solution remains the same as that proposed in Ad Hoc MW/48, i.e., that separate exclusive FS and FSS allocations be established, with the FS retaining exclusive use of its present allocation of 38.6 - 40.0 GHz and the 37 - 37.5 GHz band being kept available for future expansion. Under such a scenario there would also be ample spectrum for robust high density FSS operation.

<u>ANNEX 1</u>



Under clear air conditions power to User A & User B is approximately equal. Sidelobe of the A link transmitter (FCC Class A antenna) is 33 dB down towards User B. If rain causes 30 dB of attention (and 30 dB of power increase on Link A) User B will experience 30 dB more interference - the C/I at B due to A will go from 33 dB to 3 dB. Clearly the power on the B link will also need to be increased, which will in turn effect links C, D, etc. Rain induced scattering of power from link A into receiver B will further increase the interference level seen at B.

TABLE 2 CHARACTERISTICS OF EXAMPLE ADVANCED HDFS SYSTEMS[1]		
Modulation Type	16 QAM	256 QAM
Frequency Range (GHz)	37.0 - 40.5 GHz	37.0 - 40.5 GHz
Data Rate/Capacity (MB/sec)	90	310
Necessary Bandwidth (MHz)	50	50
Transmitter Power (dBm)	26	26
Transmit e.i.r.p. (dBW)	35 (.33m) 40 (.66m)	35 (.33 m) 40 (.66 m)
Antenna Size (meters)	.33 .66	.33 .66
Antenna 3 dB Beamwidth	1.7° 1°	1.7° 1°
Antenna Gain (dBi)	39 44	39 44
Receiver Noise Figure (dB)	5	5
Receiver Noise Temperature (°K)	917	917
Receiver Sensitivity (dBm) (Min BER 1×10^{-6})	-72	-60
Antenna Polarization	H/V	H/V

[1] The examples selected for this table are point-to-point advanced HDFS systems.

TABLE 4 EXAMPLE ADVANCED HDFS PERFORMANCE AND INTERFERENCE PROTECTION CRITERIA		
Modulation Type	16 QAM	256 QAM
Receiver Sensitivity (Min BER 1 x 10^{-6})	-72 dBm	-60 dBm
Necessary Bandwidth (MHz)	50	50
C/N (dB)	20	32
C/I (dB)	29	43
Path length (Min 99.999% availability in ITU-R Region K)	approx. 2.3 km	approx.2.3 km
Maximum allowable Interference in RF Bandwidth (dBm)	-101	-103

ANNEX 4

TSB10-F

TIA/EIA TELECOMMUNICATIONS SYSTEMS BULLETIN

Interference Criteria for Microwave Systems

TSB10-F

(Revision of TSB10-E)

JUNE 1994

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

Representing the telecommunications industry in association with the Electronic Industries Association consider the overall system noise objectives in parallel with the system reliability (outage) objectives. Most analog links require significant carrier level increases above threshold sensitivity just to achieve acceptable baseband signal-to-noise (*e.g.* >35 dB increase for 70 dB S/N in the worst message channel in an FM-FDM link).

4.3 Automatic Transmit Power Control in Digital Links

4.3.1 Introduction:

Automatic (or Adaptive) Transmit Power Control (ATPC) is a desirable feature of a digital microwave radio link that automatically adjusts transmitter output power based on path fading detected at the far-end receiver(s). ATPC allows the transmitter to operate at less than maximum power for most of the time. When fading conditions occur, transmit power will be increased as needed. ATPC is useful for extending the life of transmitter components, reducing power consumption, simplifying frequency coordination in congested areas, allowing additional up-fade protection, and (in some radios) increasing the maximum power output (improves system gain).

If the maximum transmit power in a ATPC link is needed for only a short period of time, a transmit power less than maximum may (if certain restrictions are met) be used when interference calculations are made into other systems. Many years of fading statistics have verified that fading on different physical paths is non-correlated, *i.e.* the likelihood of two paths in a given area being in a deep fade and thus sensitive to interference simultaneously is very small. Further, to allow for inevitable deep fading, microwave paths are designed with unfaded carrier-to-noise (C/N) and carrier-to-interference (C/I) ratios much greater than those required for high quality path performance. Since fading is non-correlated among paths, a short-term power increase by a path experiencing a deep fade will not reduce the C/I on other paths to an objectionable level. On a properly designed path, and one not affected by rain outage, ATPC-equipped transmitters will be at maximum power for a short period of time. However, because the maximum power is available when deep fades occur, CFM, threshold C/N, and C/I calculations into an ATPC link may assume the "Maximum Transmit Power" receive carrier level.

ATPC has been successfully implemented in FCC Part 21 common carrier bands for several years, and, under FCC *ET Docket 92-9*, is now permitted under Part 94. Currently, there are two types of ATPC available. The "ramping" type increases power dB for dB with a fade greater than a certain depth. The "stepped" type increases power in a single step to maximum power when a fade exceeds a certain depth. Besides significantly aiding the frequency coordination process, ATPC also provides receiver up-fade overload protection due to the backed-off transmit power under normal signal level conditions.

4.3.2 ATPC recommendations for frequency coordination

During the coordination process, the ATPC user must clearly state that ATPC will be used. The transmit powers associated with an ATPC system included on the coordination notice are defined as follows:

Maximum Transmit Power	That transmit power that will not be exceeded at any time, used for CFM and path reliability (outage) computations, and for calculating the C/I into an ATPC system.
Coordinated Transmit Power	That transmit power selected by the ATPC system licensee as the power to be used in calculating interference levels into victim receivers.
Nominal Transmit Power	That transmit power at or below the coordinated power at which the system will operate in normal, unfaded conditions.

The Coordinated Transmit Power is restricted to a 0 to 10 dB range below the Maximum Transmit Power. The Nominal Transmit Power must be less than or equal to the Coordinated Transmit Power, with typical values ranging from 6 to 15 dB below the Maximum Transmit Power. The receive level at which the system either steps up or begins to increase (ramp up) the far-end transmit power (depending on the type of ATPC) is referred to as the ATPC Trigger Level. Because shallow fading characteristics are path dependent and unpredictable, at least a 10 dB fade must occur before the Coordinated Transmit Power is exceeded.

In order to claim a Coordinated Transmit Power less than the Maximum Transmit Power (ATPC feature is used), certain restrictions on the time that this power is exceeded must be met. Below about 12 Ghz, the expected annual time percentages should not exceed the limits shown in Figure 4-4 and provided in Table 4-2. These time percentages can be calculated by the applicable reliability calculations as shown in Section 4.2.3. First, the fade depth that causes the transmit power to exceed the Coordinated Transmit Power by a certain number of dB must be calculated. This fade depth is then substituted for the CFM in the reliability calculation. For a ramping ATPC system that uses a step increase in transmit power, a single calculation of the time that the fade depth to the ATPC trigger level is exceeded is all that is required. For an ATPC system that increases (ramps up the) power in a linear dB for dB fashion, calculations of the time that the Coordinated Transmit Power is exceeded and the time that the Maximum Transmit Power is reached are sufficient. Future ATPC systems that boost transmit power in some other way may require time percentage calculations for the entire range of transmit power in excess of the Coordinated Transmit Power.

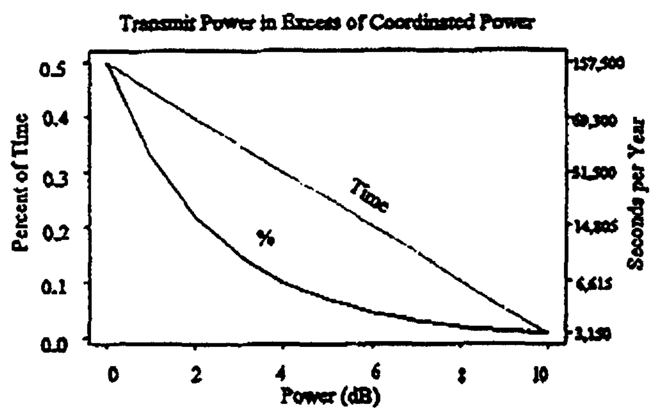


Figure 4-4 — Permitted Time Above Coordinated Transmit Power

In dB steps above the selected Coordinated Transmit Power for ramping-type ATPC systems, the permitted time percentages (and annual transmit power boost times) are shown in the following table. Only one single value (+6, +10 dB, *etc.*) need be considered in step-type ATPC systems (see examples in Section 4.3.3).

Power above Coordinated Transmit Power (dB)	Permitted time (annual)	
	Percentage of time	Seconds per year
0.0	0.50	157,500
1.0	0.33	103,950
2.0	0.22	69,300
3.0	0.15	47,250
4.0	0.10	31,500
5.0	0.07	22,050
6.0	0.047	14,805
7.0	0.032	10,080
8.0	0.021	6,615
9.0	0.014	4,410
10.0	0.010	3,150

Table 4-2 — Time Permitted Above the Coordinated Transmit Power in an ATPC Link

$$Time = 100\left(\frac{Time\text{, sec}}{31.5\times10^{6}}\right)\ \% \qquad (4.3\text{-}1)$$

ATPC-equipped transmitters that claim a Coordinated Transmit Power less than the Maximum Transmit Power must base transmit power increases on path fading. In those cases, interference or error correcting information alone is not sufficient for increasing transmit power, but either or both may be used as an additional criterion. For systems with space diversity, ATPC must be controlled by the stronger signal from the two antenna system. In calculating the time percentages above Coordinated Transmit Power, the space diversity improvement factor may be found to be less than one if the fade depth is small. In these instances, a space diversity improvement factor of one may be assumed (no improvement or penalty from using space diversity).

ATPC-equipped transmitters must not be allowed to stay in the Maximum Transmit Power mode for more than any five minute duration. This event should result in an alarm condition which returns the transmit power to the Normal Transmit Power. ATPC should then not be re-enabled until a determination has been made that this long-term anomaly has been corrected and normal operation can be resumed. This criterion will prevent a long-term degradation, such as a down-stream receiver or control channel failure falsely implying a deep fade, from causing a transmitter to be in the Maximum Transmit Power mode for an extended period of time.

If the above restrictions are met, interference calculations from an ATPC system may assume the lower Coordinated Transmit Power level. Interference and CFM calculations into the receiver of an ATPC-equipped system can then assume that the Maximum Transmit Power is in use. Thus, in calculating performance (outage, etc.) and a C/I for comparison to the objectives, the "C" is then based on the Maximum Transmit Power.

When a Coordinated Transmit Power less than Maximum Transmit Power is claimed for an ATPC system, documentation that the system will meet these recommendations should be supplied during the coordination process. Because rain fading, obstruction fading, or surface duct fading could cause an ATPC system to increase power for a much longer time, additional justification for claiming a Coordinated Transmit Power less than the Maximum Transmit Power may have to be provided for paths with inadequate clearance or long paths above about 10 GHz. Paths that do not meet the restrictions may still use ATPC, but a Coordinated Transmit Power equal to the Maximum Transmit Power must be used in the coordination process.

The cumulative yearly time at maximum transmit power and the maximum transmit power single duration event time of five minutes may not be appropriate for radios operating above about 12 GHz due to the impact of rain rates and duration on interference cases. Further study in this area is needed.

In order to best reflect ATPC operation in the licensing process, the transmit power shown in the FCC filing should be the Maximum Transmit Power of the station. The station EIRP corresponding to the Maximum Transmit Power must meet FCC EIRP requirements.

Note: ATPC is not recommended for use with analog radios because of the signal-to-noise degradation with the increase in thermal noise proportional to the normal transmitter back-off.

<u>4.3.3 ATPC time above Coordinated Transmit Power sample calculations</u>

In order to best reflect ATPC operation in the licensing process, the transmit power shown in the FCC filing should be the Maximum Transmit Power of the station. The following examples illustrate typical ATPC computations:

<u>Example 1</u>: Ramping-type ATPC is to be used on a 40 km (25 mile) 6.7 GHz path without space diversity. The ATPC trigger level is -55 dbm. Once this trigger level is reached, the system will increase transmit power one dB for every additional dB of fade. The Nominal Transmit Power of the equipment is +14 dBm with a Maximum Transmit Power of +29 dBm. Average climate, terrain, and temperature conditions exist on the path. The path is designed for a receive level, with Nominal Transmit Power, of -43 dBm. The designer wishes to check if a Coordinated Transmit Power of +19 dBm, 10 dB below the Maximum Transmit Power, can be specified under the recommendations:

A fade depth of 12 dB from -43 to -55 dBm causes the trigger level to be reached. An additional 5 dB of fade boosts the power from +14 dBm to the +19 dBm Coordinated Transmit Power. The time that the fade depth exceeds 12+5=17 dB is computed to be:

$$T = 20\,(6.7)\,(25)^3\,10^{-\left(\frac{17}{10}\right)} = 41{,}776 \text{ seconds} \tag{4.3-2}$$

or 0.1326 percent of the time, which meets the 0.5 percent requirement.

An additional 10 dB of fade will cause the transmitter to reach its +29 dBm Maximum Transmit Power. The time that the fade depth exceeds 17+10 = 27 dB is computed to be:

$$T = 20\,(6.7)\,(25)^3\,10^{-\left(\frac{27}{10}\right)} = 4{,}178 \text{ seconds} \tag{4.3-3}$$

or 0.0133 percent of the time. This does not meet the requirement of 0.01 percent of the time for 10 dB above the Coordinated Transmit Power.

Since the power is allowed to exceed the Coordinated Transmit Power by as much as 9 dB for 0.014 percent of the time, a Coordinated Transmit Power of +20 dBm (9 dB below the Maximum Transmit Power) may thus be specified.

<u>Example 2</u>: ATPC equipment that increases power in a single step to Maximum Transmit Power is to be considered on the non-diversity path in the previous example. The Nominal Transmit Power is +24 dBm for a receive level of -33 dBm. The Maximum Transmit Power is +30 dBm and the ATPC trigger level is 10 dB above the 10^{-3} BER outage threshold of -74 dBm. The designer wants to check if a Coordinated Transmit Power equal to the Nominal Transmit Power can be specified under these rules:

The ATPC trigger level is -64 dBm (10 dB above the 10^{-3} BER threshold) and a fade depth of 31 dB from the nominal power receive level will cause this trigger level to be reached. The time that the fade depth exceeds 31 dB is computed to be:

$$T_{SD} = 20\,(6.7)\,(25)^3\,10^{-\left(\frac{31}{10}\right)} = 1{,}663 \text{ seconds} \tag{4.3-4}$$

or 0.0053 percent of the time. Since a path is permitted to be 6 dB above the Coordinated Transmit Power (+24 boosted to +30 dBm) for 0.047 percent of the time, this path meets the requirement.

<u>Example 3</u>: A single-step ATPC'd transmitter is considered for a 48 km (30 mi) 6.7 GHz space diversity path with 9 m (30 ft) dish spacing. Average climate terrain and temperature conditions are present on the path. The Nominal (and Coordinated) Transmit Power is +20 dBm (+30 dBm maximum) for a -42 dBm nominal receive level. The ATPC trigger level is 10 dB above the -77 dBm 10^{-3} BER outage threshold, or -67 dBm.

The ATPC is thus triggered with <u>both</u> space diversity receivers faded from -42 dBm to -67 dBm, or 25 dB. The time that the fade depths both exceed 25 dB is computed to be:

$$T_{SD} = \frac{3 \times 10^5\,(30)^4\,10^{-\left(\frac{25}{5}\right)}}{30^2} = 2{,}700 \text{ sec} \tag{4.3-5}$$

or 0.0086 percent of the time. Since a path is permitted to be 10 dB above the Coordinated Transmit Power 0.01% of the time, this space diversity link meets the requirement.

APPENDIX B

RADIOCOMMUNICATION STUDY GROUP
ITU-R FACT SHEET

Working Party: ITU-R USWP 4-9S USWP 9B	**Document:** USWP 4-9S/23 **Info:** USWP 9-B/___
Ref: Doc. Nos. 4-9S/TEMP/13 & 4-9S/TEMP/14 Question ITU-R 107-1/9	**Date:** 10 December 1996

Document Title:

Analysis Of The Potential For Harmful Interference Between The Fixed Service And The Fixed Satellite Service In Frequency Bands Above 30 GHz

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Purpose/Objective:

To present analyses of the potential for harmful interference between representative systems in fixed service and fixed satellite service in bands above 30 GHz.

Abstract:

The results of calculations performed using representative FSS and FS system parameters demonstrate that a single mainbeam-coupled FSS space-to-Earth to FS receiver interference event could severely impact the operations of FS links under deep fading conditions. Study results also indicate that precluding harmful interference into FSS earth station receivers would require separation distances far in excess of a practical interservice coordination standard, given the defined operational objectives of the representative FS and FSS systems studied. Likely multiple entry events in the case of FS transmitters into victim FSS earth station receivers serve only to further exacerbate interference effects. Similarly, the separation distances required to protect FS stations from transmitting FSS earth station emissions in the 47.2 - 50.2 GHz band render prospects for viable co-frequency FS and FSS Earth-to-space operations impractical, given the assumed deployment objectives in the respective services. All currently identified interference avoidance methodologies are determined ineffective as mitigation techniques.

Based on the results of the analyses conducted in this study and the high-density deployment characteristics of both fixed service and fixed satellite service systems in bands above 30 GHz, co-frequency FS and FSS system operations in bands above 30 GHz do not appear to be operationally or economically feasible.

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Documents
Radiocommunication
Study Group

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UNITED STATES OF AMERICA

ANALYSIS OF THE POTENTIAL FOR INTERFERENCE BETWEEN THE FIXED SERVICE AND THE FIXED SATELLITE SERVICE IN FREQUENCY BANDS ABOVE 30 GHz
(Question ITU-R 107-1/9)
(WRC-97 Agenda Item 1.9.6)

1. INTRODUCTION

The 1997 World Radio Communication Conference (the "WRC-97 Conference") through Agenda Item 1.9.6 will consider the identification of suitable frequency bands above 30 GHz for high-density fixed service applications. The purpose of this document is to support ongoing ITU-R study efforts in Study Group 4-9S and Drafting Group 4-9S 3 by providing an analysis of the potential for interference between the fixed service ("FS") and the fixed satellite service ("FSS") in frequency bands above 30 GHz, and setting forth conclusions resulting from the output of resulting calculations. The potential effectiveness of possible interference mitigation techniques are also examined.

Calculations are performed using representative FSS and FS system parameters. The results of this study effort demonstrate that a single mainbeam-coupled FSS space-to-Earth to FS receiver interference event would severely impact the operations of FS links under deep fading conditions. Study results also indicate that precluding harmful interference into FSS earth station receivers would require separation distances far in excess of a practical interservice coordination standard, given the defined operational objectives of the representative FS and FSS systems studied. Likely multiple entry events in the case of FS transmitters into victim FSS earth station receivers serve only to further exacerbate interference effects. Similarly, the separation distances required to protect FS stations from transmitting FSS earth station emissions in the 47.2 - 50.2 GHz band render prospects for viable co-frequency FS and FSS Earth-to-space operations impractical, given the assumed deployment objectives in the respective services. Use of an e.i.r.p. mask may prove effective to protect space station receivers from FS emissions, but will only serve to exacerbate the susceptibility of victim FS receivers to interference from earth station transmissions. All currently identified interference avoidance methodologies are determined ineffective as mitigation techniques.

Based on the results of the analyses conducted in this study and the high-density deployment characteristics of both fixed service and fixed satellite service systems in bands above 30 GHz, co-frequency FS and FSS system operations in bands above 30 GHz do not appear to be operationally or economically feasible.

2. BACKGROUND

Recent advances in millimeter wave radio technology have resulted in the commercial availability of a growing range of equipments that will support FS operations in bands above 30 GHz. A substantial and rapidly growing number of FS systems are currently in operation in several administrations utilizing channel assignments in portions of the 37.0 - 40.5 GHz band. Several other fixed service bands above 30 GHz, including the 47.2 -50.2 GHz band, have been designated by a growing number of administrations for near and mid-term future FS use. Rapidly escalating interest in FS prompted the establishment of WRC-97 agenda item 1.9.6, which calls for the Conference to consider the identification of suitable frequency bands above 30 GHz for high-density fixed service applications.

FS systems can be generally characterized as high deployment density, relatively low-cost, wireless digital broadband fixed service networks. FS systems can provide a full range of digital local broadband services directly to and from customer premise-located terminals at data rates of up to one DS-3 per 50 MHz forward and return link channel pair. FS transmission paths can range up to about 6 - 7 km, depending mainly on rain attenuation conditions. FS links may be implemented in various single-hop, multi-hop, star, or other configurations, and are regularly deployed on an on-demand basis to meet specific end-user requirements as they develop. FS systems are also utilized to provide mobile network backhaul service and for other pre-determined infrastructure overlay configurations. FS systems are often deployed in dense urban environments where transmission path elevation angles may reach up to 45° and possibly higher. FS systems are also deployed to serve a range of requirements in semi-urban, suburban, and rural population centers.

Until recently, the issue of compatibility between co-primary FS and FSS operations has not presented itself as a matter requiring immediate attention. There are currently no operational commercial FSS systems utilizing spectrum in bands above 30 GHz. The first such FSS system that would utilize spectrum in these bands was proposed in early September 1996, and comprises a planned constellation of 72 non-geostationary spacecraft, with contemplated high/medium-density service ubiquitous-coverage space-to-Earth operations in the 37.5 - 40.5 GHz range and Earth-to-space operations in the 47.2 - 50.2 GHz range. Accordingly, because there are substantial current and planned FS operations in the 37.0 - 40.5 GHz band where co-primary FSS operations have been proposed, it appears prudent at this time to develop sound technical conclusions as to the potential for interference between FS and space-to-Earth FSS operations.